

Reflections on Theories of Learningⁱ

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Abstract:

Four philosophies of learning are contrasted, namely 'simple' constructivism, radical constructivism, enactivism and social constructivism. Their underlying explanatory metaphors and some of their strengths and weaknesses are contrasted, as well as their implications for teaching and research. However, it is made clear that none of these 'implications' is incompatible with any of the learning philosophies, even if they sit more comfortably with one of them.

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Construction

Constructivism has been a leading if not the dominant theory or philosophy of learning in the mathematics education research community ever since the heated controversy in the 1987 Montreal PME conference. What made constructivism such a hot issue was not just what it claims about learning. Rather it is the epistemological implications that follow from it. As one of the leading exponents of constructivism said "To introduce epistemological considerations into a discussion of education has always been dynamite" (Glaserfeld 1983: 41).

But constructivism does not represent a single school of thought, as there are several versions and varieties, some diametrically opposed to others. What binds many of the various forms of constructivism together is the metaphor of construction from carpentry or architecture. This metaphor is about the building up of structures from pre-existing pieces, possibly specially shaped for the task. In its individualistic form the metaphor describes understanding as the building of mental structures, and the term 'restructuring', often used as a synonym for 'accommodation' or 'conceptual change' in cognitivist theory, contains this metaphor. What the metaphor need not mean in most versions of constructivism is that understanding is built up from received pieces of knowledge. The process is recursive (Kieren and Pirie 1991), and so the building blocks of understanding are themselves the product of previous acts of construction. Thus the distinction between the structure and content of understanding can only be relative in constructivism. Previously built structures become the content in subsequent constructions. Meanings, structures and knowledge are emergent.

The metaphor of construction is implicit in the first principle of constructivism as expressed by von Glasersfeld (1989: 182): "knowledge is not passively

received but actively built up by the cognizing subject". One can term 'simple constructivism' those positions based on this principle alone. Basic as this simple form might be, it represents a very significant step forward from naive empiricism or classical behaviourism. For it recognizes that knowing is active, that it is individual and personal, and that it is based on previously constructed knowledge. Just getting student teachers to realize this, by reflecting on 'child methods' in mathematics or alternative conceptions in science, say, represents a significant step forward from the naive transmission view of teaching and passive-reception view of learning many student teachers arrive with. Unfortunately a passive-reception view of learning is not dead among professionals or administrators in education. Many government driven curriculum reforms, in Britain and elsewhere, assume that the central powers can simply transmit their plans and structures to teachers who will passively absorb and then implement them in 'delivering the curriculum'. Such conceptions and strategies are deeply embedded in the public consciousness, although it may be no accident that they also serve authoritarian powers (Ernest 1991). Freire (1972) is critical about the 'banking' model of learning in which inert items of knowledge are passed over to learners who have to absorb them, thus becoming passive receptors rather than epistemologically and politically empowered social agents.

What has been termed 'simple constructivism' can be applied as a descriptor to some extent to neo-behaviourist and cognitive science learning theories. These should not be dismissed too lightly. The models of cognition in the work of Ausubel, Gagné and others, are subtle and complex. As long ago as 1968 Ausubel wrote that "The most important single factor influencing learning is what the learner already knows. Ascertain this, and teach him accordingly." (Ausubel 1968: 18). This is a principle shared by most forms of constructivism, asserting that pre-existing knowledge and understandings are the basis for virtually all subsequent learning.

In discussing the metaphor of construction, there is an important distinction to be drawn between individual and social construction. The cognitivist and constructivist accounts I have referred to are based on the metaphor applied within the individual, in which a learner constructs their knowledge and understanding internally based on their personal interpretation of their experiences and their pre-existing knowledge. This account could be extended to include the individual construction of various affective responses, including attitudes, beliefs and values, and even learners' entire personalities, for some versions of constructivism. Nonetheless, this constitutes an individualistic form of construction. In contrast, another use of the metaphor lies in social construction, in which the learning and knowledge construction takes place in the social arena, in the 'space between people', even if its end products are appropriated and internalized by those persons individually.

One of the key differences between different forms of

constructivism, and learning theories in general, is whether it is assumed that absolute knowledge is attainable or not. Simple constructivism and most cognitive science theories of learning accept that true representations of the empirical and experiential worlds are possible. This is not the case with radical constructivism.

Radical Constructivism

Although it originates with Piaget, and is partly anticipated by Vico, Kant and others, in its modern form radical constructivism has been most fully worked out in epistemological terms by von Glasersfeld and colleagues. Definitionally, radical constructivism is based on both the first and second of von Glasersfeld's principles, that latter of which states that "the function of cognition is adaptive and serves the organization of the experiential world, not the discovery of ontological reality." (von Glasersfeld 1989: 182). Consequently, "From an explorer who is condemned to seek 'structural properties' of an inaccessible reality, the experiencing organism now turns into a builder of cognitive structures intended to solve such problems as the organism perceives or conceives." (von Glasersfeld 1983: 50).

This suggests an underlying metaphor for the mind or cognizing subject in radical constructivism is that of an organism undergoing evolution, patterned after Darwin's theory, with its central concept of the 'survival of the fit'. This is indicated in Piaget's notion of adaptation to the environment, and his explicit discussion of cognitive evolution, such as in Piaget (1972). According to the evolutionary metaphor the cognizing subject is a creature with sensory inputs, furnishing data that is interpreted (or rather constructed) through the lenses of its cognitive structures; it comprises also a collection of those structures all the while being adapted; and a means of acting on the outside world. The cognizing subject generates cognitive schemas to guide actions and represent its experiences. These are tested according to how well they 'fit' the world of its experience. Those schemas that 'fit' are tentatively adopted and retained as guides to action. Cognition depends on an underlying feed-back loop.

Thus on the one hand, there is an analogy between the evolution and survival of the fitter of the schemas in the mind of the cognizing subject and the whole of biological evolution of species. Schemas evolve, and through adaptation come to better fit the subject's experienced world. They also split and branch out, and perhaps some lines become extinct. On the other hand, the organism itself and as a whole, is adapting to the world of its experiences, largely through the adaptation of its schemas.

A widespread criticism of radical constructivism and indeed of other learning philosophies based on the individual conception of construction is that the account of the cognizing subject emphasizes its individuality, its

separateness, and its primarily cognitive representations of its experiences. Its representations of the world and of other human beings are personal and idiosyncratic. Indeed, the construal of other persons is driven by whatever representations best fit the cognizing subject's needs and purposes. None of this is refutable. But such a view makes it hard to establish a social basis for interpersonal communication, for shared feelings and concerns, let alone for shared values. By being based on the underlying evolutionary metaphor for the mind there is a danger that interpersonal relations are seen as nothing but competitive, a version of the 'law of the jungle'. After all, this is but another way of phrasing 'the survival of the fit'. Yet society and its functions, in particular education, depend on articulated and shared sets of concerns and values. Values which are most evidently subscribed to by radical constructivists themselves. Thus the paradigm needs to accommodate these issues by balancing knowing with feeling, and acknowledging that all humans start as part of another being, not separate.

Enactivism

Since the 1990s, following the publication of the influential work *The Embodied Mind* (Varela *et al.* 1991), enactivism has become increasingly popular as a theory of learning among mathematics education researchers. One of the central ideas is that of autopoiesis. This is the property of complex dynamic systems of spontaneous self-organization, based on feedback loops and growth in response to this feedback. Enactivism is a theory of cognition as "the enactment of a world and a mind on the basis of a history of the variety of actions that a being in the world performs" (Varela *et al.* 1991: 9). In other words, the individual knower is not simply an observer of the world but is bodily embedded in the world and is shaped both cognitively and as a whole physical organism by her interaction with the world. "Enactivism as a theory of cognition acknowledges the importance of the individual in the construction of a lived world, but emphasizes that the structure of the individual coemerges with this world in the course of, and as a requirement for, the continuing inter-action of the individual and the situation." (Reid *et al.* 2000: I-10)

Another source of enactivism is the theory of the bodily basis of thought via the role of metaphors, drawing on the work of George Lakoff and Mark Johnson (Lakoff and Johnson 1980, Johnson 1987). This proposes that all human understanding, including meaning, imagination, and reason is based on schemes of bodily movement and its perception ("image schemata", Johnson 1987: xiv). These are extended via metaphor ("metaphorical projection" op. cit. xv), providing the basis for all human understanding, thought and communication. Recently Lakoff and Núñez (2000) even developed the ideas embodied metaphors so as to offer an account of the discipline of mathematics.

These bases of enactivism provide a rich and powerful explanatory theory for learning and being. It is being

applied in a number of research studies, especially by Canadian researchers in mathematics education. However, I want to suggest that it is not so very different from Piaget's epistemology and learning theory and the radical constructivism to which it gave birth. Indeed Piaget and Bruner are the only two psychologists that are charted in the territory of enactivism in the map provided by Varela *et al.* (1991: 7). After all, Piaget's central mechanism of equilibration (the achievement of balance within the knower in response to perturbations) is based on a similar biological model of a being in interaction with its environment.

Reid (1996: 2) claims that "There is an important distinction to be made, however, with some constructivist perspectives. It is not a matter of an individual having a cognitive structure, which determines how the individual can think, or of there being conceptual structures which determine what new concepts can develop. The organism as a whole is its continually changing structure which determines its own actions on itself and its world. This holistic vision of the cognitive entity is central".

However, this seems to me to be a matter of emphasis rather than a major shift. Perhaps more significant is the emphasis of enactivism on metaphor, which does not figure so explicitly in Piaget (or radical constructivist accounts). Piaget does emphasise 'reflective abstraction' as a mechanism whereby concepts and schemas are abstracted and generalized, and metaphorical thinking might be seen as one of the modes of this.

The assumption that bodily metaphors and their enactivist/imagistic basis provide the foundations for subsequently more developed concepts is not without its weaknesses. "Bachelard regards the common-sense mind's reliance on images as a breeding ground for epistemological obstacles ... [these] are often not explicitly formulated by those they constrain but rather operate at the level of implicit assumptions or cognitive or perceptual habits." (Gutting 1990: 135). Thus naïve notions like those derived from bodily metaphors may underpin misconceptions, such as the quasi-Aristotelian notions that Alternative Frameworks researchers in science education have documented extensively (Pfundt and Duit 1991)

What both enactivism and radical constructivism appear to share is the subordination of the social or the interpersonal dimension, and indeed the existence of other persons to constructions and perceived regularities in the experienced environment. The knowers' own body might be a given, albeit emergent, but other persons' bodies and overall beings are not. Ironically, language, which is the primary seat of metaphor, is the quintessential social construction. But language, like other persons, seems to be removed and exterior to the primary sources of knowledge of the enactive self in these perspectives.

Social Constructivism

There are a variety of social constructivist positions, but for simplicity I shall treat them as one, based on the seminal work of Vygotsky. Social constructivism regards individual learners and the realm of the social as indissolubly interconnected. Human beings are formed through their interactions with each other as well as by their individual processes. Thus there is no underlying model for the socially isolated individual mind. Instead, the underlying metaphor is dialogical or 'persons-in-conversation', comprising socially embedded persons in meaningful linguistic and extra-linguistic interaction and dialogue (Harré 1989, Ernest 1998). However, this metaphor for conversation is not the bourgeois chatter of the dining or breakfast-table (e.g., Holmes 1873) no matter how profound the discussion. Rather it is like the directed talk of workmen accomplishing some shared task, such as "bring me a slab" (Wittgenstein 1953: 8). In Wittgensteinian terms these social contexts are shared 'forms-of-life' and located in them, shared 'language-games'.

From this perspective, mind is viewed as social and conversational, because first of all, individual thinking of any complexity originates with and is formed by internalised conversation. Second, all subsequent individual thinking is structured and natured by this origin; and third, some mental functioning is collective (e.g., group problem solving, sign-based learning). These assumptions stem from the Vygotskian developmental account of the origins of language in the individual as something that is internalised and appropriated from social functioning. Vygotsky (1978) describes how the spontaneous concepts that children form through their perceptions merge with the more 'scientific' concepts that are linguistically mediated that are acquired through such social activity. Through play the basic semiotic fraction of signifier/signified begins to become a powerful factor in the social (and hence personal) construction of meaning. Thus for Vygotsky bodily activities result in spontaneous concepts but these only become abstracted (e.g., into metaphors) through symbolic mediation, i.e., the acquisition, structuring and use of language and other semiotic systems.

Conversation offers a powerful way of accounting for both mind and learning. A Vygotskian theory of the development of mind, personal identity, language and knowledge, can be represented in a cycle of appropriation, transformation, publication, conventionalisation. This shows different aspects of the use of signs, understood here within a semiotic perspective that sees signifiers as any publicly presented or uttered representation or text and signifieds as meanings that are often woven indissolubly into the social and cultural fabric through the roles and patterns of use of the signs. Beyond this, the component activities of sign reception and production involved in language games are woven together within the larger epistemological unit of conversation (Ernest 1998 Harré and Gillett 1994, Shotter 1993). A schematic model of

the way in which these two activities are mutually shaping is shown in Figure 1.

Figure 1. Model of Sign Appropriation and Use

		<i>Social Location</i>	
		Individual	Collective
<i>Ownership</i>	Public	Individual's public utilization of sign to express personal meanings	Conventionalisation → Conventionalized and socially negotiated sign use (via critical response & acceptance)
		Publication ↑	↓ Appropriation
	Private	Individual's development of personal meanings for sign and its use	← Transformation Individual's own unreflective response to and imitative use of new sign utterance

Figure 1 illustrates how signs become appropriated by an individual through experiencing their public use. In the first instance this leads to the learner's own unreflective response to and imitative use of signs, based on the perceived regularity (rule-based) and connectivity of use within the discursive practice. After a series of such uses and public sign utterances, in which the whole cycle may be brought into play in miniature, a nexus of implicit rules and associations with actions and signs for the sign are learned. In this process the individual develops personal meanings for the sign and its use, transforming it into something that is individually and privately owned. The individual is now able to utilize the sign in autonomous conversational acts, the publication stage, which can vary in scope from relatively spontaneous utterances, to the construction of extended texts. These productions are subject to the process of conventionalisation in which an individual's public sign utterances offered in various modes of conversation are subjected to attention and response which can be critique, negotiation, reformulation or acceptance.

The process of conventionalisation takes place at the visible centre of the Zone of Proximal Development (Vygotsky 1978) in which the learner experiences and is guided by interventions over public sign use. The processes of appropriation and publication are boundary operations between the public and private domains in which the learner participates in the communicative activity of sign reception and production. In the private domain the learner transforms collective signs into individual ones through the production of meaning, and is thus a pivotal location for learning. In fact the ZPD might be said to encompass all four quadrants in which sign use is being learned.

The model thus describes an overall process in which both individual and private meanings and collective and public expressions are mutually shaped through conversation. Knowledge and the meaning of the full range of signs texts and other cultural forms of

representation is distributed over all four quadrants of the model. The model represents a micro view of learning and of knowledge production. However it is limited in its focus in that it does not accommodate the issues of power and the larger social structures through which knowledge, power and economics are mutually constitutive and circulate. For this a further analysis of knowledge is required, beyond what can be given here.

Implications for educational practice

Ultimately, the import of a learning theory concerns its implications for practice, both pedagogically, in the teaching (and learning) of mathematics, and in the practice of conducting educational research. However, in my view, there is little in any pedagogy that is either wholly necessitated or wholly ruled out by the other elements of a learning theory. Similarly, learning theories do not imply particular research approaches. Nevertheless, certain emphases are foregrounded by different learning theories, even if they are not logical consequences of them.

Simple constructivism suggests the need and value for:

- (1) sensitivity towards and attentiveness to the learner's previous learning and constructions,
- (2) identification of learner errors and misconceptions and the use of diagnostic teaching and cognitive conflict techniques in attempting to overcome them.

Radical constructivism suggests attention to:

- (3) learner perceptions as a whole, i.e., of their overall experiential world,
- (4) the problematic nature of mathematical knowledge as a whole, not just the learner's subjective knowledge, as well as the fragility of all research methodologies.

Enactivism suggests that we attend to:

- (5) bodily movements and learning, including the gestures that people make,

(6) the role of root metaphors as the basal grounds of learners' meanings and understanding.

Social constructivism places emphasis on:

(7) the importance of all aspects of the social context and of interpersonal relations, especially teacher-learner and learner-learner interactions in learning situations including negotiation, collaboration and discussion,
 (8) the role of language, texts and semiosis in the teaching and learning of mathematics.

However, each one of these eight focuses in the teaching and learning of mathematics could legitimately be attended to by teachers drawing on any of the learning theories for their pedagogy, or by researchers employing one of the learning theories as their underlying structuring framework.

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ⁱ Throughout this paper for brevity what I refer to as learning theories might more accurately be termed philosophies of learning. Some might argue that these 'theories' are not specific or testable (i.e., falsifiable) enough to deserve this title.